CHAPTER 6

ECONOMIC BENEFITS

ECONOMIC BENEFITS

There is much anecdotal evidence that Kentucky has made progress in protecting its water resources. In recent 305(b) reports, approximately two-thirds of streams and rivers assessed have been seen to be are meeting standards designed to protect aquatic life, swimming, and public water supply. Of more than 100 public lakes monitored, approximately two-thirds fully support swimming, fishing, and drinking water uses. Such evidence is helpful in discerning program benefits broadly. However, to measure the benefits of water programs adequately, it is necessary to define a set of parameters and value changes in these parameters in a consistent and meaningful way.

In Appendix A of the 1994 Kentucky Report to Congress on Water Quality, the Trend Analysis and Data Summary Tables provide evidence of statistically significant improvements in water quality. The parameters chosen for the trend analysis were followed for several years in each of Kentucky's river basins. A parameter is considered to follow a trend toward improvement if a linear regression of the parameter on years is appropriately positive or negative. However, there has been no attempt to place value on these changes in such a way that their importance, both relative and absolute, can be ascertained.

In the following sections we will consider how best to measure the benefits of Kentucky's efforts in protecting stream, river and lake water quality, groundwater quality, and water quantity. First, one useful scheme for classifying water quality and quantity benefits is presented. Then, a list of benefit values gathered from studies deemed respectable by economists and public policy experts is provided.

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A Classification of Water Quality Benefits

The benefits of water quality are many and varied. With some slight variation within the discipline, an approach to classifying benefits has been developed by economists. Table 1 provides one classification scheme for benefits.

First, benefits can be labeled as either Intrinsic or Use. Intrinsic Benefits include Option Value, the value of possible access to a resource in the future, and Existence Value, the knowledge that a resource exists. Use Benefits are categorized as Indirect or Direct. Indirect benefits are those which do not require actual contact with a resource. For example, the values of fishing equipment, lake-front property, and beautiful scenic views all involve the use of water, but only in an indirect way. Direct Benefits involve contact with the given resource. Direct Benefits can be examined more closely.

Direct Benefits may be classified by the consumption of the resource. Swimming and Boating are examples of Non-Consumptive Direct Use Benefits.

Consumptive Benefits are as varied as the quantity of municipal water supplies and the quality of recreational fishing. These Consumptive Benefits can be categorized by their ability to be valued in the market system. Some benefits, such as quality irrigation water for agriculture and the better catches for commercial fishermen, are easily expressed by the market. Such benefits are called Market Benefits. Other benefits, known as Non-Marketed Benefits, include such things as recreational fishing.

Table 6-1. Classification of Benefits

Use Benefits	Intrinsic Benefits
Direct	
Consumptive *Market*	**Option Value**
Consumptive *Nonmarket*	**Existence Value**
Non-Consumptive	
Indirect	

Representative Water Benefit Value Estimates from Respected Studies

Although there have been many applied studies evaluating the benefits of water, there are few studies specific to Kentucky. For example, there are more than 510,000 jobs associated with waterborne commerce in the Ohio Valley states along the Ohio River from the movement of commodities that have a 1980 dollar value of $43 billion (Palmer, 1985), but there are no estimates for the effects on Kentucky alone. However, there are some indicators of each of the various types of benefits of Kentucky's water resources.

Drinking water is one type of marketable consumptive direct-use benefit. Approximately 2.9 million people (81 percent of the Kentucky population) use public or semi-public water supplies, while 500,000 people (14 percent of the Kentucky population) use private wells for domestic water (Kentucky Outlook 2000, 1995). The daily water supplies for about 70 percent of Kentuckians come from surface-water sources, while about 25 percent come from ground-water sources.

A non-marketable consumptive direct use benefit of Kentucky's water is recreational fishing. The "National Survey of Fishing, Hunting, and Wildlife--Associated Recreation, Kentucky" (1991) reported that 647,000 Kentucky residents (36 percent of the Kentucky population), and 714,400 U.S. residents, fished in Kentucky streams during 1990-1991. The same report found that the in-state trip-related expenditures for fishing were $162.3 million (or $227 dollars per person). These expenses include some indirect use benefits such as food, lodging, transportation, license fees, and bait. The "1991 Kentucky Angler Survey," (1991) found that the average Kentucky angler fished 23.7 days in 1991. The anglers reported that they were fishing less than they had in the past, and fewer Kentucky residents under the age of 16 were purchasing licenses.

The use of Kentucky's lakes as camping sites is a type of non-consumptive direct-use benefit. William Hoyt (1989) was able to show that for each additional 100 acres of lake, there is an increase of 22 overnight camping

stays, everything else held constant. However, Hoyt showed that lakes do substitute for one another. For every lake within 35 miles of any other one lake, 840 overnight stays are lost.

An example of the intrinsic value of Kentucky's water resources is the value people in the state place on the existence of a wetland. Whitehead and Blomquist (1990) showed that Kentucky citizens were willing and able to pay a one-time fee between $3 and $13 to keep the Clear Creek wetland in Kentucky from potential surface coal mining. These fees estimate existence value because only 16 percent of the surveyed sample had actually visited the wetland.

Many studies outside Kentucky have been conducted concerning water benefits. A collection of values intended for use as a reference point in the creation of realistic hypothetical models of watershed quality benefit valuation is presented in Appendix A6-1. Those studies which have followed state-of-the-art benefit measurement techniques have been used to provide at least one value for several benefit types. Some benefit categories include more than one value while other categories are excluded altogether due to a lack of quality studies in the area. These values have some usefulness in estimating the order of magnitude for various water quality benefits across different use categories.

WATER QUALITY BENEFIT VALUATION
APPENDIX A6-1

Outline of Value Types

I. Instream Benefits

- A. Hydropower
- B. Recreation
- C. Aquatic Habitat Preservation
- D. Other Instream Benefits
  - 1. Waste
  - 2. Navigation

II. Withdrawal Benefits

- A. Domestic
- B. Commercial and Industrial
- C. Irrigation

I.A. Hydropower

This table provides a list of Short-run marginal Values of Water for Hydroelectric Power Generation on four rivers. Power plants, with feet of head, and cumulative feet of head for each power plant along the rivers are given. Then the Cumulative kWh per acre-foot is given. Finally Cumulative Water Values in (1980) dollars per acre-foot is given. (Gibbons, 1987),

Plant	Feet of Head	Cumulative Feet of Head	Cumulative kWh	Cumulative water values
Columbia River				
Bonneville	59	59	51.33	0.87
The Dalles	83	142	123.54	2.10
John Day	105	247	214.89	3.65
McNary	74	321	279.27	4.75
Priest Rapids	77	398	346.26	5.89
Wanapum	78	476	414.12	7.04
Rock Island	38	514	447.18	7.60
Rocky Reach	87	601	522.87	8.89
Wells	67	668	581.16	9.88
Chief Joseph	167	835	726.45	12.35
Grande Coulee	343	1178	1024.86	17.42
Snake River				
Ice Harbor	98	419	364.53	6.20
Lower Monu.	100	519	451.53	7.68
Little Goose	98	617	536.79	9.13
Lower Granite	100	717	623.79	10.60
Hells Canyon	210	927	806.49	13.71
Oxbow	120	1047	910.89	15.49
Brownlee	277	1324	1151.88	19.58
Swan Falls	24	1348	1172.76	19.94
C.J. Strike	88	1436	1249.32	21.24
Bliss	70	1506	1310.22	22.27
Lower Salmon Falls	59	1565	1361.55	23.15
Upper Salmon Falls	80	1645	1431.15	24.33
Shoshone Falls	212	1857	1615.59	27.47
Twin Falls	147	2004	1743.48	29.64
Minidoka	48	2052	1785.24	30.35
American Falls	107	2159	1878.33	31.93
Tennessee River				
Kentucky	50	50	43.50	0.78
Pickwick Landing	46	96	83.52	1.49
Wilson	93	189	164.43	2.94
Wheeler	48	237	206.19	3.68
Guntersville	39	276	240.12	4.29
Nickajack	39	315	274.05	4.89
Chickamauga	45	360	313.20	5.59
Watts Bar	54	414	360.18	6.43
Fort Loudon	70	484	421.08	7.52
Colorado River				
Shoshone	170	170	147.90	2.51
Palisades	80	250	217.50	3.70
Glen Canyon	566	816	709.92	12.07
Parker	78	894	777.78	13.22
Davis	131	1025	891.75	15.16
Hoover	530	1555	1352.85	23.00

I.B. Recreation

This table provides estimates for various types of recreational uses of water. When known, the location of the study is given.

Benefit Type	Location	Value	Study
Boatable Water	National	$93 (1993) annual household value	Carson-Mitchell 1993
Kayaking	Colorado	$3.60 (1980) daily value per kayaker per acre foot of instream flow	Walsh et al. 1980
Rafting (White Water)	Colorado	$2.36 (1980) daily value per kayaker per acre foot of instream flow	Walsh et al. 1980
Swimmable Water	Boston	$46.10 (1981) per household per year	Gramlich,1977
	National	$78 (1993) annual household value	Carson-Mitchell 1993
From Boatable to Swimmable	Monongahela	$14.71 (1981) per household per season	Smith,Desvousges and McGivney 1983
Fishable	National	$70 (1993) annual household value	Carson-Mitchell 1993
From Boatable to Fishable	Monongahela	$7.01 (1981) per household per season	Smith,Desvousges and McGivney 1983
	Monongahela	$0.98-$2.03 (1982) per person per trip	Smith,Desvousges and McGivney 1983
	Cold Water Area	$1.00-$3.00 (1982) per person per day	Loomis-Sorg, 1982
		$4.00-$8.00 (1982) per person per day	Vaughan-Russell, 1982
Rough Fishing to Game Fishing (Catfish to Trout)		$5.76-$8.64 (1981) per person per day	Charbonneau-Hay 1978
		$4.55-$9.10 (1981) per person per day	Vaughan-Russel, 1982
Boating, Swimming, Fishing (Total)	National	$242 (1993) annual household vlaue	Carson-Mitchell 1993
10% Reduction in oil, color, and bacteria pollution	Boston	$1.34 (1981) per capita per year	Feenberg and Mills, 1980

I.C. Aquatic Habitat Preservation

Option, Existence, and Bequest values will indicate the value of preservation, and examples are provided in the first two tables that follow. WTP values for endangered species can also be found. A Whooping Crane Value is given in the third table as an example.

Table 1 (Greenley, Walsh, and Young):

Annual and Present Social Values (1980 dollars) from Water Quality Preservation in the South Platte River Basin, Colorado

Area Surveyed	Option value	Bequest value	Existence value	Recreation value	Recreation and Preservation value
Denver Metro.					
Annual Value	2,042,682-6,161,700	2,366,693-6,981,107	2,732,107-11,060,147	5,330,492-16,886,624	12,471,974-41,089,578
Present Value	32,42,078-96,654,102	37,124,596-109,507,561	54,920,408-173,492,502	83,615,571-264,888,216	207,702,653-664,542,381
Fort Collins					
Annual Value	193,236-548,307	94,651-348,562	132,461-419,523	417,390-1,191,622	837,702-2,508,014
Present Value	3,031,153-8,600,896	1,484,157-5,467,634	4,125,956-6,580,752	6,547,290-18,692,110	15,188,556 39,341,192
South PlatteRiver Basin					
Annual Value	3,581,687-10,526,153	3,118,513-9,782,102	3,792,942-14,399,346	8,658,460-26,399,220	19,151,602-61,106,821
Present Value	56,183,321-165,116,132	48,917,856-153,444.736	59,497,134-225,892,099	135,818,977-414,105,414	300,417,288-958,538.381

Table 2:

Preservation values per household

Study	Location	Total WTP	Recreation Use	Option	Existence	Bequest
Clonts-Malone 1988 (in 1987 dollars)	Alabama	57	8	9.50	22.50	17
Aiken, 1985 (in 1983 dollars)	Colorado	58	15	12	13	17

Table 3 (Bowker and Stoll, 1988):

WTP (1988 dollars) per individual for Whooping Crane Conservation: $21-$141.

I.D. Other Instream Benefits

Table 1. Waste

This table provides regional values (in 1980 dollars per acre-foot) of the water required for BOD Dilution. The first value is the marginal cost of moving from a 35% dillution level to a 70% municipal and a 50% industrial treatment level. The second value is for the least-cost combination of treatment and dilution. References: Gibbons (1986) and Gray and Young (1974).

Region	70/50 % Treatment	Least-cost combination
New England	1.25	1.25
Delaware and Hudson	2.41	4.83
Chesapeake	0.68	1.20
Ohio	3.41	3.52
Eastern Great Lakes	0.94	1.31
Western Great Lakes	0.37	1.68
Upper Mississippi	4.57	2.52
Lower Mississippi	2.98	2.15
Upper Missouri	1.16	4.03
Lower Missouri	6.81	5.82
Upper Arkansas-White-Red	1.47	6.98
Lower Arkansas-White-Red	1.99	1.99
Southeast	0.37	0.57
Cumberland	1.05	0.63
Tennessee	0.15	2.04
Western Gulf	0.68	1.36
Rio Grande and Pecos	0.79	3.63
Colorado	0.15	0.63
Great Basin	0.42	0.48
Southern Pacific	0.74	1.57
Central Pacific	0.48	1.31
Pacific Northwest	0.20	0.48

Table 2. Navigation

This table contains the short-run Average Values of Water for Navigation on Selected Waterways. First the Water Requirement is given (in thousands of acre-feet per year). Then Total Water Values in thousands of dollars is provided (determined by subtracting operation and maintenance costs of the waterways from the savings over railroad costs). Finally the Total Water Values are divided by the Water Requirement to get the Average Water Values in dollars per acre-foot. Source: Gibbons (1986).

Waterway	Water Requirement	Total Water Values	Average Water Values
Ohio River	604.80	166,067.06	275
Illinois Waterway	119.84	28,600.83	239
Tennessee River	412.16	21,374.00	52
Mississippi River	131,040.00	758,547.50	6
Columbia /Snave Rivers	7,168.00	19,013.92	3
Missouri River	23,968.00	3,229.65	<1

II.A. Domestic

This table provides the marginal values for Residential Water Demand in 1980 Dollars per hundred cubic feet.

Season	Location	Marginal Value ($/hundred cubic feet)	Study
Winter	Arizona	$0.72	Young, 1973
	North Carolina	1.27	Danielson, 1977
	Ontario	0.79	Grima, 1972
Summer	Arizona	$0.83	Young, 1973
	North Carolina	1.23	Danielson, 1977
	Ontario	0.79	Grima, 1972

II.B. Commercial and Industrial

This table shows the Impact of Water Pollution Control Requirements on Water Costs and Recycling Rates. Water is used in the production process and it is assumed a firm will operate on the cost minimization principal unless otherwise controlled. The "Best Available Treatment" here is based on 1975 data. The Total Costs are in 1980 dollars per acre foot of water used in the four different applications. Source: Gibbons, 1986.

Application	Total Cost-No Control	Total Cost-Best Available Treatment
Non-contact cooling water	21	33
Integrated cotton textile mill	162	465
Unbleached Kraft paper Mill	41	75
Basic oxygen steelmaking operations	56	192

II.C. Irrigation

This table provides the values of water used for irrigation of various crops. The values are in terms of 1980 Dollars per acre-foot. These are average values unless otherwise specified with an"M" for marginal.

Crop	Location	Value	Study
Alfalfa	Colorado	$25	Young, 1984
	Arizona	15	Willitt, et al., 1975
Apples	Washington	86	Washington State Univ., 1972
Barley	Arizona	5	Willitt, et al., 1975
Beans (Dry)	California	25-41	Shumway, 1973
Carrots	Arizona	313	Martin and Snyder1979
Corn	Washington	31	Washington State Univ., 1972
	Texas	67	Lacewell, et al., 1974
Cotton	Arizona	89-166	Kelso, et al., 1974
Cotton (Pima)	Arizona	51	Martin and Snyder, 1979
Cotton (Upland)	Arizona	55	Willitt, et al., 1975
Grain Sorgham	Arizona	23	Martin and Snyder, 1979
	Texas	113 (M)	Hoyt, 1982
Hops	Washington	10	Washington State Univ., 1972
Lettuce	Arizona	118	Martin and Snyder, 1979
Melons	California	21-40+	Shumway, 1973
Onions (dry)	Arizona	23	Martin and Snyder, 1979
Pears	Washington	78	Washington State Univ., 1972
Potatoes	Idaho	282-698 (M)	Ayer, et al., 1983
Safflower	California	15-28	Shumway, 1973
Soybeans	Texas	101	Lacewell et al., 1974
Sugar Beets	California	22	Shumway, 1973
	Washington	144 (M)	Ayer, 1983
Tomatoes	California	390 (M)	Kelley and Ayer, 1982
Wheat	Arizona	30-32	Kelso et al., 1974
	Texas	27	Lacewell et al., 1974

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CHAPTER 7

CONCERNS AND RECOMMENDATIONS

CONCERNS AND RECOMMENDATIONS

Concerns that are significant issues in Kentucky affecting its water quality programs:

- Making the transition to a watershed approach, including the cycling of permits without creating a backlog and monitoring and assessment that will properly focus limited resources.
- Erosion of program budget, resulting in loss of staff and other resources.
- Implementing new antidegradation regulations in a fair and consistent manner to further protect known and potential high quality waters.
- Providing policy makers, permit writers, and others with sound environmental data on which to base decisions.
- Resolving enforcement actions.
- Reducing time devoted to permit adjudications.
- Promoting public awareness of the division's successful programs and its role in improving the water environment.
- Comprehensively evaluating sanitary wastewater collection systems, including pump stations.
- Providing the technical and financial support to help municipalities maintain their wastewater treatment facilities and reduce wet weather flows from inadequate collection systems.
- Re-engineering the permitting and other water programs for greater effectiveness and efficiency
- Effectively implementing elements of the Agricultural Water Quality Plan

Recommendations to achieve further progress in meeting the goals and objectives of the Clean Water Act:

- Increase training to municipal and industrial wastewater treatment personnel on the implementation of pretreatment programs.
- Develop and implement practical alternatives for on-site waste disposal.
- Strengthen and update the requirements of the 201 planning process to promote wastewater regionalization.
- Re-establish Section 314 Clean Lakes funding for better assessing the condition of the state's lakes.
- Address problems in water distribution systems, which are not now effectively regulated.
- Initiate permitting system for drinking water plans.

- Institute performance bonds for package plants and oil and gas wells.

- Guidance is needed on stormwater and combined sewer overflow permitting in regard to: development of wet weather criteria, appropriate governing stream flows for water quality-based permits, the need to apply human health-based criteria for carcinogens, appropriate sampling techniques, and available and appropriate treatment procedures.

- Research at the federal level is needed to develop a logical progression of steps to identify and determine ways to eliminate chronically toxic components of effluents. National guidelines are needed to develop consistency in the implementation of whole effluent toxicity limits with the NPDES program.

- Greater financial support and simplified administration requirements should be provided to small communities (<3500 population), and possibly even individuals, for both water supply and sanitary sewer systems.